Susceptibility of Australian plant species to *Phytophthora ramorum*

Authors: **K.B. Ireland[1*], D. Hüberli[1], B. Dell[1], I.W. Smith[2], E.J. Fichtner[3], D.M. Rizzo[3] and G.E. St J. Hardy[1]**

[1] Cooperative Research Centre for National Plant Biosecurity and Centre for Phytophthora Science and Management, Faculty of Sustainability, Environmental and Life Sciences, Murdoch University, Murdoch, Western Australia 6150, Australia

[2] Department of Forest and Ecosystem Science, Melbourne School of Land and Environment, University of Melbourne, Victoria 3121, Australia

[3] Department of Plant Pathology, University of California Davis, Davis CA 95616, USA.

* Presenting author. Email: k.ireland@murdoch.edu.au

Summary

The pathogenicity of *Phytophthora ramorum* on Australian native plants was assessed using detached leaf and branch inoculations. Results indicate the potential for *P. ramorum* to infect and colonise a range of Australian native plant species from different families.

Introduction

Phytophthora ramorum, the cause of Sudden Oak Death in California, is an invasive plant pathogen causing considerable and widespread damage in nurseries, gardens and natural woodland ecosystems of the USA and Europe (Brasier *et al.* 2004; Rizzo *et al.* 2002; Werres *et al.* 2001) and is classified as a Category 1 pest in Australia (Plant Health Australia 2006). It is of particular concern to Australian plant biosecurity as, like *P. cinnamomi*, it has the potential to become a major economic and ecological threat in areas with susceptible hosts and conducive climate. Research was undertaken in California, USA, to assess pathogenicity of *P. ramorum* on Australian native plants.

Methods

A total of 67 test species within 24 families were sourced from established gardens and arboretums in Northern California. Species were selected based upon provenance from areas of climatic suitability for *P. ramorum*, as well as ecological and economical importance to Australian plant industries. Species were duplicated where possible from different locations or accessions, making for a total of 126 individual plants tested. The known susceptible host *Rhododendron* 'Colonel Cohen' was used as a positive control across all experiments.

Detached leaf and branch assays were used to test for susceptibility, following the protocols of Denman *et al.* (2005) and Hüberli *et al.* (2008) respectively, and using isolate Pr510 from the culture collection of the Rizzo Lab (UC Davis, CA). Duplicate experiments were conducted in the Summer of 2008 and Winter of 2008/2009. Wounded foliar inoculations were only done during the summer. All plant material were kept in moist chambers at 20-25°C and 16 hours daylight during summer, and 15-20°C and 12 hours daylight during winter. The *Phytophthora* selective medium PARP was used for both foliar and branch studies to confirm infection.

Preliminary analysis of the results was undertaken to compare the species amongst one another, based only on averages of the recorded data. Foliar susceptibility was grouped based upon disease severity supported by re-isolation into non-hosts (0%), low susceptibility (<15%), moderate susceptibility (15-30%), high susceptibility (30-45%) and very high susceptibility (>45%). Branch susceptibility was simply listed from smallest to largest lesion length.

Results and Discussion

Foliar inoculation results indicate that the majority of species tested are susceptible to *P. ramorum* in varying degrees. Only *Hedycarya angustifolia* tested completely negative in both wounded and unwounded inoculation rounds. No trends were found to indicate particular plant families or genera to be more susceptible than another. Of note is that both *Isopogon* species

tested were highly susceptible, and as they are important species in the international cut flower and nursery industries, could prove to be important in disease spread or epidemiology in Australia. *Agonis flexuosa* tested moderately to highly susceptible, dependent upon their provenance. *A. flexuosa* is a common West-Australian native planted widely as a street tree both on the east coast of Australia and west coast of California, making it an ideal candidate for spread of the disease through native and nursery settings. Many Eucalypt species tested highly susceptible, including *Eucalyptus paucifolia* (Snow Gum), *E. sideroxylon* (Red Ironbark) and *E. nitens* (Shining gum), an important native forest and plantation species. A list of highly and very highly susceptible species is given in Table 1.

Table 1: Highly and very highly foliar susceptible species of Australian plants to *Phytophthora ramorum*. Disease Severity (DS) is a measure of the percentage of the leaf infected, Disease Incidence (DI) is a measure of the number of leaves infected, and Infection Potential (IP) is a measure of percent re-isolation.

	Unwounded			Wounded			Susceptibility Category
	DS	DI	IP	DS	DI	IP	
Isopogon formosus	91.7	85.6	73.3	58.2	94.4	72.8	Very High
Leptospermum scoparium	84.5	85.7	82.1	94.9	91.1	87.8	Very High
Leptospermum lanigerum	75.1	90.0	85.8	84.6	88.3	82.1	Very High
Melaleuca squamea	73.0	90.9	88.4	89.4	100.0	100.0	Very High
Correa reflexa	69.2	93.3	89.1	72.5	100.0	97.2	Very High
*Isopogon cuneatus**	58.5	100.0	100.0	50.5	100.0	100.0	Very High
*Correa 'Sister Dawn'**	57.0	80.0	80.0	56.5	100.0	96.7	Very High
*Eucalyptus paucifolia**	56.4	100.0	96.7	45.7	100.0	96.7	Very High
Podocarpus lawrencei	50.0	0.0	0.0	97.4	55.0	52.5	Very High
Adenanthos obovatus	49.8	55.0	55.0	60.1	95.0	90.0	Very High
Eucalyptus sideroxylon	49.2	87.5	79.3	60.0	97.5	84.2	Very High
*Taxandria marginata**	47.7	100.0	100.0	10.4	80.0	70.0	Very High
Rhododendron 'Colonel Cohen'	41.0	87.5	83.0	52.7	97.8	96.7	High
*Eucalyptus cneorifolia**	37.1	93.3	66.7	25.9	100.0	93.3	High
*Eucalyptus nitens**	36.9	93.3	90.0	38.5	93.3	90.0	High
*Banksia attenuata**	36.5	93.3	83.3	16.0	100.0	73.3	High
*Atherosperma moschatum**	33.5	33.3	20.0	35.3	86.7	70.0	High
Lomatia myricoides	33.4	70.0	40.0	13.6	60.0	42.5	High
Prostanthera lasianthos	32.3	70.0	60.0	12.6	75.0	54.5	High
Corymbia ficifolia	31.3	85.0	90.0	53.5	100.0	98.8	High

* Species without replication

Results of summer branch inoculations indicate less highly susceptible species than those with foliar inoculations. The twenty species with the greatest average lesion length is shown in Table 2. *Isopogon formosus*, *E. nitens* and *E. sideroxylon*, all highly susceptible in foliar inoculations, were again highly susceptible on branches. Interestingly *Hedycarya angustifolia*, not susceptible at all in the foliar trials, was highly susceptible in branch inoculation trials. In general many of the eucalypts appear to be susceptible to *P. ramorum* branch dieback. No trends indicating a correlation between foliar and branch inoculation were detected.

Table 2: Branch susceptibility of Australian plant species to *Phytophthora ramorum*

	lesion length (mm)	% reisolation
Eucalyptus leucoxylon ssp. Megasperma JUV	175.50	75
Rhododendron 'Colonel Cohen'*	122.28	90
Isopogon formosus	65.96	79
Eucalyptus leucoxylon	63.25	100
Hedycarya angustifolia	42.91	75
Eucalyptus nitens	42.38	75
Eucalyptus sideroxylon	41.88	88
Eucalyptus viminalis	34.75	94
Acacia melanoxylon	33.06	50
Hardenbergia violaceae	31.81	73
Eucryphia lucida	23.56	69
Leptospermum lanigerum	22.34	80
Eucalyptus delegatensis	22.19	88
Acacia dealbata	21.63	85
Eucalyptus camaldulensis	20.69	94
Grevillea synapheae	19.63	56
Olearia argophylla	19.06	46
Eucalyptus leucoxylon ssp. Megasperma	18.78	88
Nothofagus cunninghamii	15.00	100
Banksia marginate	14.04	88
Taxandria marginata	13.88	100

* Positive control ^ Accurate measurement unable to be made due to dieback

These results clearly indicate the potential for *P. ramorum* to infect and colonise a range of Australian native plant species from different families. Initial results also indicate seasonal variability, as has been shown in previous inoculation studies with *P. ramorum* (De Dobbelaere *et al.* 2007; Tjosvold *et al.* 2007). Inoculum concentration, foliar sporulation and log susceptibility are planned to be investigated. These results will provide the basis for climate and spread models to predict the pathogen's spread and impact on Australian plant industries and natural ecosystems should an incursion occur. Risk predictions generated by the models and an understanding of the pathogen's host range will allow the targeting of high risk areas for early detection surveillance and protection, and assist regulators in developing appropriate quarantine protocols.

References

Brasier C., *et al.* Mycological Research, 2004. 108(10): p. 1108-1110.

Rizzo D.M., *et al.* Plant Disease, 2002. 86(3): p. 205-214.

Werres S., *et al.* Mycological Research, 2001. 105: p. 1155-1165.

Plant_Health_Australia, *National Nursery and Garden Industry Biosecurity Plan.* 1 ed. 2006, Deakin: Plant Health Australia.

Denman S., *et al.* Plant Pathology, 2005. 54(4): p. 512-521.

Huberli D., *et al.* Australasian Plant Pathology, 2008. 37(6): p. 615-625.

De Dobbelaere I., Huengens K., and Maes M., *Effect of Environmental and Season Factors on the Susceptibility of Different Rhododendron Species and Hybrids to Phytophthora ramorum.* in *Sudden Oak Death Science Symposium III.* 2007. Santa Rosa, CA, USA.

Tjosvold S., Chambers D., and Blomquist C., *Seasonal Symptom Expression, Laboratory Detection Success, and Sporulation Potential of Phytophthora ramorum on Rhododendron and Camellia.* in *Sudden Oak Death Science Symposium III.* 2007. Santa Rosa, CA, USA.